

# ELECTRICAL INSPECTION BULLETIN

**B-64-200**

**Solar Photovoltaic Installations**



*(Effective 08/07/2022)*

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## **Objective**

To provide direction on the installation of Solar Photovoltaic Systems. This Bulletin supplements, clarifies or amends the requirements set forth by the Canadian Electrical Code C22.1 - 2018. See additional notes at the end of this document.

## **Definitions**

**Micro Inverter** - A solar micro-inverter, or simply microinverter, is a plug-and-play device used in photovoltaics, that converts direct current (DC) generated by a single or multiple solar modules to alternating current (AC).

**String Inverter** - A string inverter is connected to a series or “string” of solar panels and converts the power from Direct Current (DC) in to Alternate Current (AC) electricity, for the solar system as a whole.

## **Maximum Circuit Loading**

CE Code Rule 64-100 requires that the maximum current of the inverter output circuit shall be the inverter continuous output current rating. Output circuits connected to these devices are to be sized based on this continuous output rating and are not to be based on input load calculations or battery banks if any. Some inverters may have specifications listing sustained maximum output currents, and the higher of these numbers or the rated output should be used.

In cases where the inverter output can be factory set or field programmed to limit the maximum continuous output an exception to this rule will be allowed. These programmed settings shall be locked or program protected in such a way that access to change these settings by non-certified personnel or a homeowner is impossible. In these cases, a legible / permanent lamicoid label, white letters on RED background shall be installed on or adjacent to the inverter and the main AC disconnect switch. Where micro-inverters are used a label is only required on the main AC disconnect switch.

This label is to read as follows: **“Maximum Inverter Output Set at XX Amps - NOT TO BE EXCEEDED”**

## **Rodent Protection Requirements**

CE Code Rule 64-210 (5) requires that photovoltaic DC source circuit insulated conductors or cables that are installed on or above a building and in accordance with Subrules 1), 2) & 3) shall be provided with mechanical protection in the form of an enclosed raceway or other acceptable material in order to protect against damage from rodents. This requirement shall only apply to DC string inverter systems. Micro-inverter installations shall not be required to have this additional rodent protection. In all cases however; mechanical protection if deemed necessary shall still be required. (ex: exposed RPVU type cabling)

In scenarios where rodent protection is required, use of rodent guard mesh sleeves approved for the purpose may be used for installation under the modules and along module racking only. Rodent guard mesh sleeves of any kind shall NOT be used as just mechanical protection or as a raceway system beyond the solar array boundary.

## **Wiring Methods**

CE Code Rule 64-210 (2) & (3) indicate that type RPVU cables and manufacturer supplied module cabling greater than 30V shall be inaccessible to the public. This can be achieved by location of the array, complete fencing of the array or complete mesh/panel coverings to prevent hand contact. Other suitable methods may be acceptable with NSPI approval prior to installation.

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To Clarify these requirements:

- Achieved by location means on the roof of a dwelling or other building without permanent roof access. In cases where the building roof can only be accessed by authorized personnel for maintenance purposes this is acceptable.
- Complete Fencing shall be a permanent chain link or wooden fence structure minimum height 5FT complete with locking gate access. Chicken wire supported by push-in stakes or strapped to array structures is not acceptable.
- Complete wire mesh / panel coverings shall be installed on the back of the array system fastened securely to the array racking using screws / washers. This wire mesh covering shall be a metallic type, have openings  $\frac{1}{4}$ " x  $\frac{1}{4}$ " maximum and installed in such a way to ensure no one can touch the RPVU type cabling or the connectors. This means all RPVU cabling shall be secured tightly and away from the wire mesh covering. In other words, shall not lay against it. (**Plastic meshing or coverings are not acceptable**)

**Example of an acceptable installation:**



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**Example of unacceptable installation:**



**Equipment Bonding**

CE Code Rule 64-070 requires that the bonding connection between the grounding conductor and exposed conductive surfaces of the renewable energy source or supply circuit equipment shall be made in such a manner that disconnection or removal of the equipment will not interfere with or interrupt bonding continuity.

Bond conductor sizes shall be minimum #6AWG copper or #4AWG aluminum in all cases when exposed. Exceptions to this requirement are as follows:

- The bond conductor within a factory assembled cable (ie: Teck90 cable). The factory supplied bond conductor is acceptable.

Or

- The bond conductor runs within a complete conduit system with no exposure of the bond conductor. In this case the bond conductor shall be sized as per Table 16 requirements.

Bonding of the rack system - All bonding shall be installed as per the manufacturer's installation instructions and applicable code requirements.

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#### **Rapid Shut-Down Requirements**

CE Code Rule 64-218 requires photovoltaic rapid shutdown to be provided for photovoltaic systems installed on or in buildings where the photovoltaic (DC) source or (DC) output circuit insulated conductors or cables on or in buildings are more than 1m from a photovoltaic array.

A device used to initiate photovoltaic rapid shutdown shall be readily accessible and located as follows. Note this requirement can be complied with in some cases by the disconnect means referred to in the next section.

- For single dwelling units at the supply authority meter location. This also includes installations where photovoltaic modules are installed only on a detached garage or other outbuilding / ground mounted array.
- For other than single dwelling units, at the consumer's service equipment or supply authority meter location and at a permanent access to a building roof where an array is installed or within sight and within 9m of the array.

#### **Disconnecting Means Requirements**

CE Code Rule 64-060 (1) requires that a disconnecting means shall be provided to disconnect simultaneously all ungrounded conductors supplied from a renewable energy power supply source (DC source conductors) from all other insulated conductors in a building or other structure (AC source conductors).

CE Code Rule 84-022 requires that a disconnect means shall be provided to disconnect simultaneously all the electric power production sources from the supply authority system.

To facilitate these requirements the following arrangements shall be followed. These requirements shall be deemed as meeting both requirements of CE Code Rule 64-060 (1) and 84-022. **Note: Other code rules that indicate the requirement for a disconnecting means to be installed for any other purpose are still required; ex: Fuse Isolation 64-060 (8), DC combiner 64-060 (12).**

For the purposes of this document the disconnect means shall be located within 1m of the meter base or a ground mounted array. When located on a detached garage or other outbuilding without a meter base they shall be located on the exterior of the building in a readily accessible location.

- For a single dwelling unit with photovoltaic installations installed on the roof of the dwelling unit only, a single disconnect means shall be provided. The disconnect means shall be located at the meter base location.
- For a single dwelling unit with photovoltaic installations installed on the roof of the dwelling unit as well as the roof of a detached garage or other outbuilding a disconnect means shall be provided both at the detached garage or other out building and at the meter base location. Where photovoltaic installations are only mounted on the detached garage or other outbuilding a disconnect means shall be provided both at the detached garage or other out building and at the meter base location.
- For a single dwelling unit with a photovoltaic ground mounted array a disconnect means shall be provided both at the ground mounted array and at the meter base location.



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- For other than single dwelling units with photovoltaic installations installed on the roof such as stand-alone detached garages, other outbuildings and ground mounted arrays that are connected direct to the utility grid by means of a single utility service connection a disconnect means shall be provided at the meter base location. For a ground mounted array with the meter base remotely mounted a disconnect means shall be provided both at the ground mounted array and at the meter base location.
- For other than single dwelling units such as commercial buildings with photovoltaic installations installed on a roof a disconnect means shall be provided at the photovoltaic array on the roof, at the consumers service equipment and at the meter base location. If a ground mounted array is used a disconnect means shall be installed at the ground mounted array, at the consumers service equipment and at the meter base location.

In situations where locating the disconnect means in the identified locations is not practical due to meter base locations, accessibility issues or other circumstances permission may be granted prior to installation to locate the disconnect means in an alternate location. In this case a permanent label shall be installed adjacent the meter base or service equipment to indicate the actual location of the disconnecting means. When an alternate disconnect switch location has been approved, the alternate location and additional signage shall be identified clearly with their plans review submission.

For scenarios other than those identified above contact NSPI prior to design and installation.

### **Alternate Solar PV Connections**

#### Approved Dual Lug Meter Base:

Where a solar photovoltaic system is installed on the supply side of the service disconnecting means, CE Code Rule 64-112 (2), using a dual lug meter base the disconnect shall be service entrance rated. The neutral conductor shall be installed and terminated at the disconnecting means.

#### Second Utility Service Installation (CE Code Rule 6-102):

Where a solar photovoltaic system is installed direct to the utility grid where a utility service already exists the following requirements shall apply.

- Where the solar PV installation is installed completely exterior to the building structure (ie: junction boxes, inverters, cabling, disconnects, etc...) this is not considered a second service per CE Code Rule 6-102.
- In the case where the solar PV installation or any part of it (ie: junction boxes, inverters, cabling, disconnects, etc...) are required to be located or run within the building a deviation to CE Code Rule 6-102 shall be obtained as this is considered a second utility service per rule 6-102.

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### Combination Solar / Back-up Generator installations

#### Auto-Transfer Schemes

In the case of an auto-transfer generator installation that is installed in conjunction with a solar application a means of automatically isolating the solar system when the generator is activated shall be provided. This shall be achieved by means of auxiliary contacts or other manufacturer approved means.

#### Manual Transfer Schemes

In the case of a manual transfer generator installation that is installed in conjunction with a solar application a legible permanent warning sign shall be provided as follows: This signage shall be posted at the transfer switch location.

**“Caution: De-energize all Solar Systems before Starting Generator”**. White letters on red background (sized to suit)

Note: Transfer schemes that require the generator to be manually started (ex: generlink installations) shall be considered as a manual scheme.

### Diagrams & Labelling Requirements

CE Code rule 84-030 requires that a warning notice of an interconnected system and a permanent, legible single line diagram of the complete interconnected system shall be installed in a conspicuous location at the supply authority disconnecting means. For the purposes of this rule the single line diagram shall only be required to be located inside at the main service panel and at any sub panels associated with the photovoltaic system. Laminated paper, aluminum plates, lamicoïd plates and/or other protective coverings shall be acceptable as long as they are securely fastened.

CE Code rules 64-060 to 64-222 require various types of labelling that pertain to photovoltaic installations. The following is a list of some but not all of these minimum requirements and typical wording. Alternate similar wording or abbreviated wording will be acceptable. Other labelling requirements not listed are still required where indicated by the Canadian Electrical Code C22.1.

All labels must be permanent lamicoïd engraved plates, legible, white lettering on RED background, sized per CE Code requirements. Where equipment size makes some labels impractical reduced lettering sizes are acceptable as long as they are legible.

Location: Main Panel / PV Breaker

**“SOLAR INPUT - Do Not Relocate Breaker Position”**

Location: Disconnect Means (DC Roof Combiners / Ground DC Combiners)

**“PHOTOVOLTAIC SYSTEM DC DISCONNECT”**

Location: Main Panel Disconnect & Exterior Disconnect Means

**“PHOTOVOLTAIC SYSTEM AC DISCONNECT”**

Location: Main Panel & Meter Base

**“WARNING: Dual Supplies Utility Grid & Photovoltaic Power Source”**

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Location: Main Panel & All Disconnects

**“WARNING – ELECTRIC SHOCK HAZARD”**

**“Both Line and Load Sides May Be Energized In the Open Position”**

Location: Exterior DC Disconnect Means

**“OPERATING VOLTAGE XXX VDC**

**OPERATING CURRENT XX A**

**MAX SYSTEM VOLTAGE XXX VDC**

**SHORT CIRCUIT CURRENT XX A”**

Location: Exterior AC Disconnect Means

**“OPERATING VOLTAGE XXX VAC**

**OPERATING CURRENT XX A”**

Location: Main Consumers Service Location & Exterior Disconnect Means (May be the same exterior disconnects as noted above)

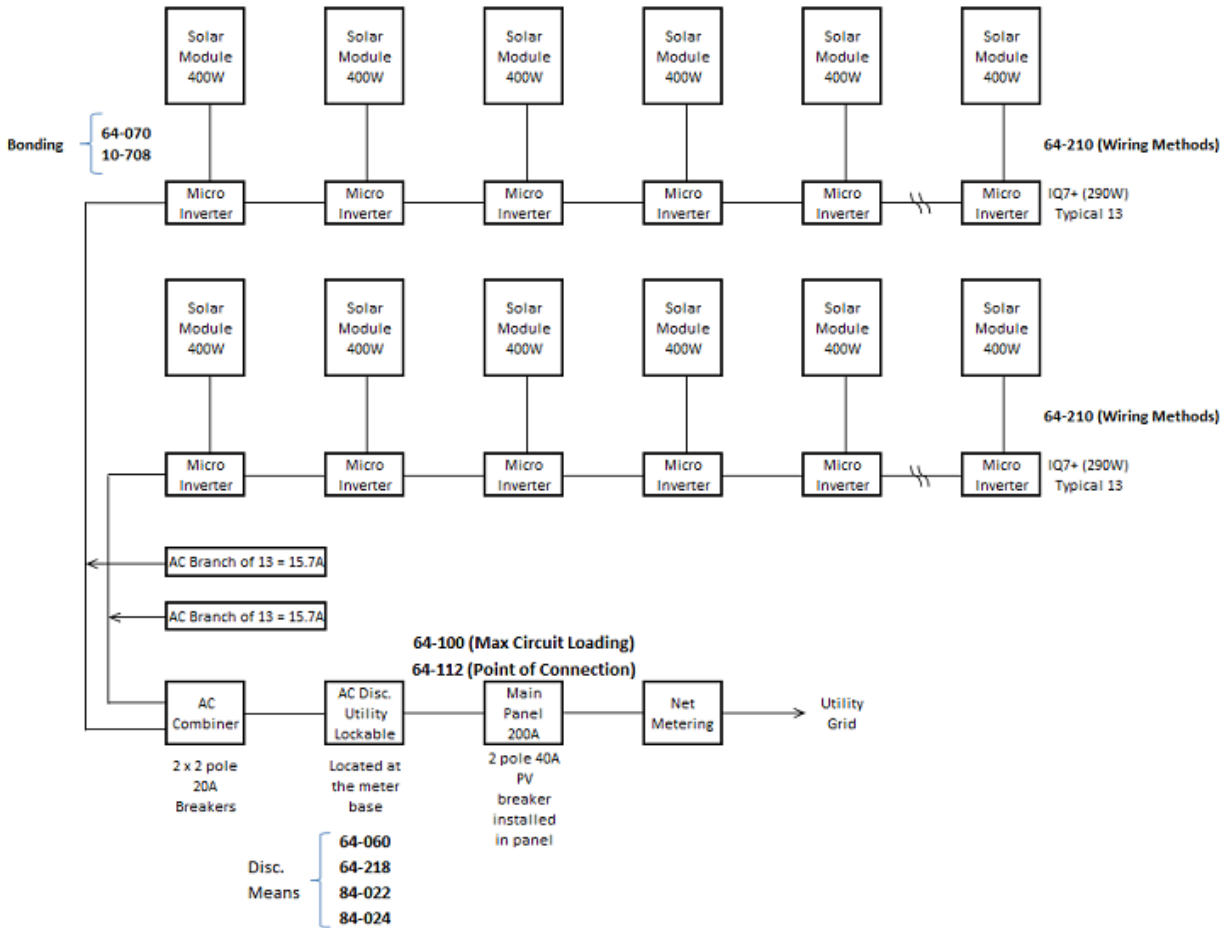
**“WARNING – Photovoltaic System Equipped With Rapid Shutdown”**

Location: Exterior DC Disconnects, DC transition boxes

**“WARNING – DC Conductors Ungrounded and May Be Energized”**

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**Typical Micro-Inverter Installation**



**Sample AC Output Calculations:**

IQ7+ Micro Inverter = 290W Max Continuous

290W x 26 Total = 7540W

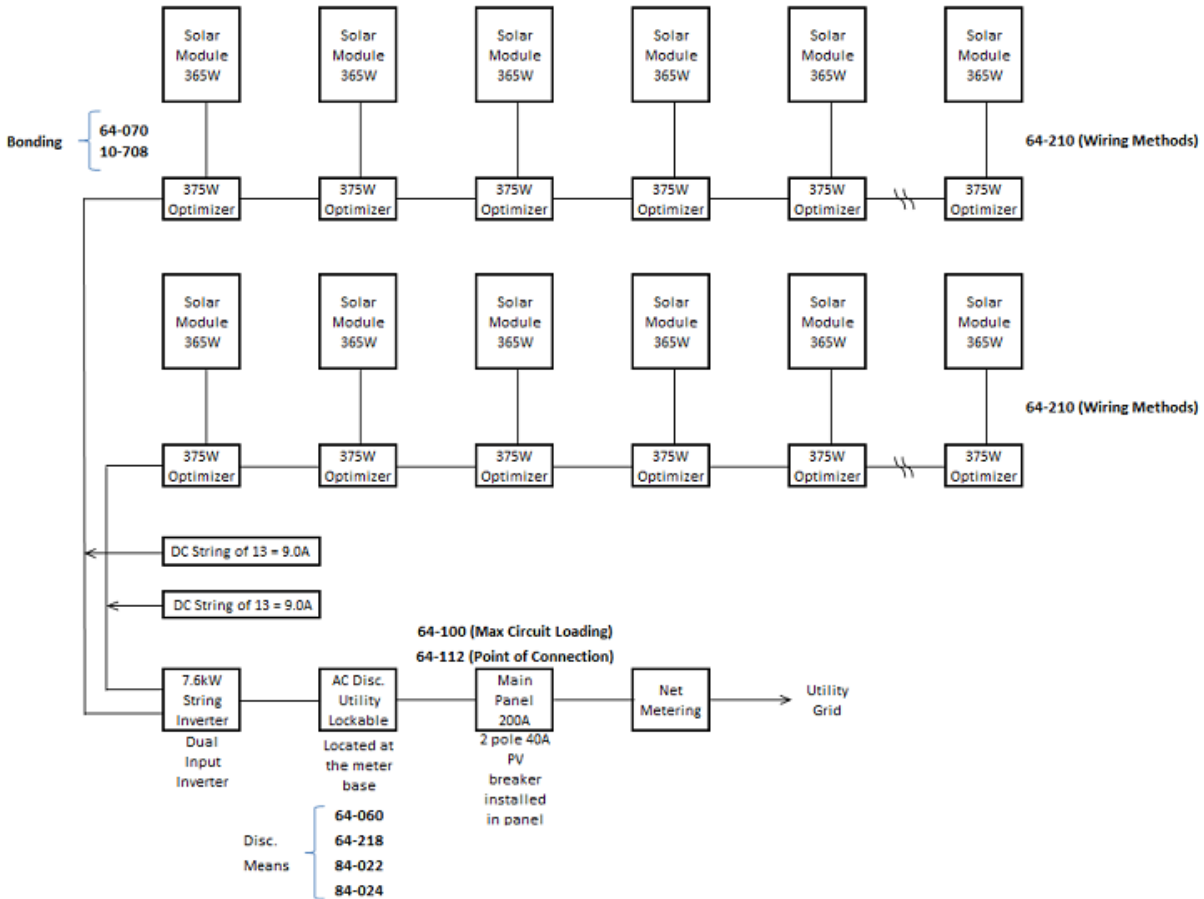
7540W / 240V = 31.4A

31.4A x 1.25 = 39.25A (Therefore next standard breaker = 40A)



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**Typical String Inverter Installation**



**Sample AC Output Calculations:**

7.6KW String Inverter = 7600W Max Continuous

$$7600W / 240V = 31.7A$$

31.7A x 1.25 = 39.62A (Therefore next standard breaker = 40A)

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### **Notes:**

1. All solar photovoltaic installations regardless of off-grid or utility interactive shall have both a rough-in inspection and a final inspection. The rough-in inspection shall require as a minimum installation all plug & play cabling, junction boxes on the roof, installation of micro-inverters or optimizers and rack bonding. Everything that will be covered up by the solar module installations or not visible at the time of inspection. This may also include undergrounds for ground mounted arrays, cabling inside buildings that will be covered, etc... (Exceptions to this requirement shall be approved by NSPI prior to equipment installations)
2. It is the installation contractor's responsibility to have a certified electrician on-site for all inspections to arrange for safe access to roofs, panelboards, junction boxes or for questions related to their installations. If a contractor is unable to be on-site at the time of the inspection and an issue or clarity is required, this may delay acceptance of their inspection and rebooking will be required.
3. Disconnecting Means Section 84, CE Code Rule 84-024 (1) c) indicates that contact operation is verifiable by direct visible means. This is only required for installations greater than 750V.
4. All solar photovoltaic disconnect switches shall be kept de-energized until bi-directional meter is installed, and final inspection is complete. A short duration allowance will be accepted for testing purposes only. It is the contractor's responsibility to make sure these switches are turned off and the owner is informed not to energize until bi-directional meter is installed. Any installations deemed as not meeting these requirements may be de-energized and sealed by NSPI at any time.
5. Reference NSPI Bulletin B-2-014 for submittal of electrical plans requirements. All single lines submitted shall be legible complete with all electrical equipment specifications, wire types & sizes, monitoring equipment, bonding, etc...
6. Disconnect switches and other arc producing devices such as utility smart meters with integral disconnects, combiner panels and inverters shall not be located within 1 meter of a natural gas relief vent or 3 meters of a propane gas relief vent.